Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Central and Arctic Region
Canadian Science Advisory Secretariat
Science Response 2014/003

UPDATE OF STOCK STATUS INDICATORS FOR NORTHERN SHRIMP, *Pandalus borealis*, AND STRIPED SHRIMP, *Pandalus montagui*, IN THE WESTERN AND EASTERN ASSESSMENT ZONES

Context

Fisheries and Oceans Canada (DFO) Resource Management requested an update of Science advice on the stock status of the two species of shrimp, Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*), in the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ). The Zonal Advisory Process (ZAP) for the EAZ and Shrimp Fishing Areas (SFA) 4-6 is scheduled for a full assessment of each SFA biennially (odd numbered years) with updates of the key indices of the Precautionary Approach (PA) framework in intervening years. The EAZ has been fully assessed twice as an assessment zone (DFO 2011, 2013) and twice prior as SFA 2 (DFO 2008, 2010). Because of the current biennial ZAP schedule, new survey data are only available on update years. The survey area which became the WAZ was fully assessed in 2010 (DFO 2010) and 2008 (DFO 2008). DFO 2012 updated the resource status in the EAZ and WAZ. Assessments follow the framework developed in 2007 for Northern Shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007a). A series of fishery-independent surveys and fishery data form the basis of the update (see DFO 2011 for details).

This Science Response Report results from the Science Response Process of January 2014 on the update of stock status indicators for Northern Shrimp and Striped Shrimp in the Western and Eastern Assessment Zones.

Background

The EAZ and WAZ were adopted as the basis for assessing the status of shrimp in SFA 2 and 3 at the 2011 ZAP (DFO 2011). The outline of the EAZ and WAZ combined is equivalent to the combined area of SFA 2 and 3. A new management system for the area of SFA 2 and 3 was approved by the Minister and co-management boards in 2012 and implemented for the 2013/14 fishing season. New management measures include the following:

- three new SFAs, Nunavut, Nunavik and Davis Strait, were established reflecting the three jurisdictions present within the area (Fig. 1),
- these new SFAs were further subdivided into management units which fall entirely within either the EAZ or WAZ (Fig. 1);
- a Total Allowable Catch (TAC) would be set for *P. borealis* and a TAC would be set for *P. montagui* for both the EAZ and WAZ based on results of surveys conducted in each assessment zone thereby eliminating quotas that could be fished in multiple SFAs which existed previously;
- the TAC would be divided by maintaining existing quotas within an area where possible or by a sharing agreement;

- an initial exploitation rate of 10% for both species was agreed to for the WAZ because this is a renewed fishing area and the survey time series is limited; and
- the EAZ would be managed to the previously accepted 15% exploitation rate.

Subsequently it was agreed that Nunavut and Nunavik quota could be fished in either the Nunavut Land Claims Area or Nunavik Marine Region.

As a result of these management changes, the TACs in the WAZ increased from 1,000 t to 5,000 t for *P. montagui* and from the 400 t to 1,500 t for *P. borealis*. In the EAZ, the TAC for *P. borealis* reduced by 150 t to 9,000 t because the borealis by-catch quota was reduced. Eliminating overlapping quotas and taking into account survey results reduced the TAC for *P. montagui* from 6,300 t to 2,250 t. TACs were based on survey data available through 2010 and were maintained until implemented for the 2013/14 season and do not reflect changes in the resource biomass since then. This update is the first review of stock status since the changes were implemented in the fishery.

Two exploitation rates are presented for each assessment zone and species because the TAC generally is not fully taken. Exploitation rate refers to the realized exploitation rate based on reported catch while the potential rate assumes the TAC had been caught.

Resource status was evaluated within a Precautionary Approach (PA) framework (DFO 2006). Reference points (RP) were based on the geometric mean of SSB. The Limit Reference Point (LRP) is 30% of the mean and the Upper Stock Reference (USR) is 80% of the mean. RPs for SFA 2 were developed (DFO 2009) and implemented in the Integrated Fisheries Management Plan (IFMP) (DFO 2007b). These RPs were transferred unchanged to the EAZ. RPs for the Western Assessment Zone were developed using the same method (DFO 2013).

In the EAZ, the first two years of survey data (2006-2007) are not considered comparable with the rest of the series because of poor trawl performance and incomplete sampling coverage in the Resolution Island survey area. These years are not considered when assessing trends in the indices from the EAZ.

Update of Indicators

Eastern Assessment Zone – *P. borealis*

Fishery

The total catch (directed and by-catch) of *P. borealis* in the EAZ as of 3 January 2014 was 6,794 t, 75% of the TAC (Fig. 2). Since the 2013/14 fishery runs until 31 March 2014, catch records may not be complete. However, ice conditions typical in January should have curtailed fishing in the zone and so most of the catch for the season has likely been included. The majority of catch taken in the EAZ comes from SFA DS-W (Fig. 1) southeast of Resolution Island and east of the Nunavut and Nunavik Land Claims borders.

Biomass

The fishable biomass index has declined serially from 78,530 t in 2011 to 49,637 t in 2013 (Fig. 3a). The female spawning stock biomass (SSB) index showed a similar decline from 47,807 in 2011 to 32,049 t in 2013 (Table 1, Fig. 3b). While the point estimates indicate a decline, the yearly differences are not statistically significant. Both biomass indices have declined since 2011 and are currently below the long term mean (2008-2013) of the time series.

Exploitation

The reported exploitation rate (ER) index for 2013/14 was 13.7%, which is above the long term average of the time series (Fig. 4a). The potential ER index calculated from the base TAC has

trended upward since 2011/12 and is estimated at about 18% for 2013/14 (Fig. 4b) with about a 22% chance of being above the maximum removal reference[1]. This trend is a direct result of the declining biomass. However, year to year differences are not significant. Season bridging amounts further increased the 2013/14 TAC from 9,000 to 9,767 t. If this amount had been taken the resulting ER would have been 19.7% with over a 40% chance of exceeding the maximum removal reference[1].

Current Outlook

The SSB for *P. borealis* in the EAZ is currently well within the Healthy Zone of the PA Framework (Fig. 5).

Eastern Assessment Zone – *P. montagui*

Fishery

The catch of *P. montagui* in the EAZ declined steadily from about 4,000 t in 2000 to about 135 t by 2011/12 (Fig. 6). Increased fishing effort around Resolution Island within the land claims areas in 2012/13 increased the catch to 1,173 t. As of 3 January 2014, the 2013/14 catch was about 1,075 t. It is likely this represents the majority of catch for the season as ice conditions should have curtailed fishing.

Biomass

The 2013 fishable biomass index was about 3,534 t and the SSB index was 2,777 t (Table 2, Fig. 7). The large increase in both biomass indices in 2012, which was about two times greater than the previous maximum, would now appear to be an extreme survey year-effect, the results of which cannot be considered reliable in the context of the time series. Disregarding the 2012 estimate, both indices appear to be on a declining trend since 2009.

Exploitation

The reported ER index had varied without trend from 2008/09 through 2012/13 averaging 11% (Fig. 8). The decrease in biomass combined with a similar catch in 2013/14 to the previous season resulted in a large increase in the ER to about 30% for 2013/14 (Fig. 8). The potential ER index has a mean of 60.6% when the 2012/13 ER is disregarded because of the unreliable biomass from the 2012 survey. The potential ER for 2013/14 was 63.7%.

Current Outlook

The SSB in the EAZ entered the Cautious Zone in 2010 and except for the abnormal survey estimate of 2012 remained there. For 2013/14 there is about a 32% chance the resource is in the Critical Zone (Fig. 9). It is recommended that the TAC for 2014/15 be reduced. It is further recommended that managers develop a rebuilding plan for EAZ *P. montagui* since the resource is approaching the established Limit Reference Point and there is a significant chance it is in Critical Zone.

Western Assessment Zone – *P. borealis*

Fishery

With the implementation of a new management regime in the north, quotas for directed fishing of *P. borealis* were established for the first time in the WAZ for the 2013/14 fishing year at

[1] 20% ER is the maximum removal reference point in the Healthy Zone accepted by the PA Working Group but not yet adopted the Northern Shrimp Advisory Committee or implemented by Fisheries Management.

1,500 t (Fig. 10). Catch records as of 3 January 2014 show that about 973 t or 65% of the TAC had been caught. While the fishery is still open until 31 March 2014 and records may be incomplete it is likely that this catch will represent the majority taken in 2013/14.

Biomass

The fishable biomass and SSB indices, while insignificantly different year to year, appear to be on an upward trend (Table 3, Fig. 11). The mean fishable biomass index over the four surveys was about 18,000 t, while the mean SSB index was about 5,800 t. In 2013, the fishable biomass index was 22,000 t and the SSB index was 9,800 t.

Exploitation

P. borealis catch increased significantly in 2013/14 over earlier years in the WAZ (Fig. 10). This increased the ER to 4.4% (Fig. 12a) based on the catch reported through 3 January 2014. The existing TAC, if taken, would result in a potential ER of 6.8% (Fig. 12b). The potential rate is lower than the 10% initial ER accepted as part of the new management system.

Current Outlook

The SSB for *P. borealis* in the WAZ is currently well within the Healthy Zone of the PA Framework (Fig. 13) established at the 2013 ZAP (DFO 2013). Since both biomass indices are trending upward and the potential ER is below the 10% initial ER accepted by stakeholders during the developmental stages of the WAZ, a small increase in the TAC for *P. borealis* for the 2014/15 fishing season could be considered.

Western Assessment Zone – *P. montagui*

Fishery

Results from the research survey series renewed interest in fishing shrimp within the WAZ. Increased effort resulted in increased catch of *P. montagui* each year from 2010/11 (Fig. 14). The new management system significantly increased the TAC from 1,000 t to 5,000 t for the 2013/14 fishing season. *P. montagui* catch significantly increased accordingly with reported catches of 4,867 t or about 97% of the TAC through 3 January 2014 (Fig.14). Records may be incomplete since the fishery is still open until 31 March 2014 but this likely represents the majority of the total catch for 2013/14.

Biomass

The fishable biomass and SSB indices have not changed significantly in the four surveys conducted (Table 4, Fig. 15). However, fishable biomass observed in 2013 is the lowest in the series (Fig. 15a). SSB was also slightly lower in 2013 but remains above the four-year series mean (Fig. 15b). The mean fishable biomass index for the four surveys was about 54,500 t, while the mean SSB index was about 24,200 t. In 2013, the fishable biomass index was 45,650 t and the SSB index was 26,960 t.

Exploitation

With the TAC increase and corresponding catch, the ER has increased significantly in 2013/14 to 10.7% (Fig. 16a). Since 97% of the TAC was taken, potential ER was only slightly higher at 11% (Fig. 16b). The potential rate is higher than the 10% target accepted for the development of the WAZ fishery by stakeholders. This is a direct result of the lower fishable biomass observed in 2013 than that used to establish the TAC.

Current Outlook

The SSB for *P. montagui* in the WAZ is currently well within the Healthy Zone of the PA Framework (Fig. 17) established at the 2013 ZAP (DFO 2013).

Conclusions

Eastern Assessment Zone

Pandalus borealis

- The *Pandalus borealis* resource is currently in the Healthy Zone well above the Upper Stock Reference.
- The mean exploitation rate, based on reported catch, for 2008-2013 is 9%. Decreases in biomass over the past two years have increased the 2013 estimate to 13.7%.
- The mean potential exploitation rate, based on the Total Allowable Catch, for 2008-13 is 14%. Decreases in biomass over the past two years have increased the 2013 estimate to 18.1%, with a possibility of being over the maximum removal reference, if taken.

Pandalus montagui

- The *Pandalus montagui* female spawning stock biomass index continues to decline, now in the lower quarter of the Cautious Zone approaching the Limit Reference Point. There is a 32% probability of being in the Critical Zone.
- The reported exploitation rate estimate for 2013/14 is high at 30%. The potential exploitation rate for 2013/14 is very high at 64%.
- It is recommended that the Total Allowable Catch for *Pandalus montagui* in the Eastern Assessment Zone be reduced to a level considered more sustainable.
- It is further recommended that managers develop a rebuilding plan for *Pandalus montagui* in the Eastern Assessment Zone.

Western Assessment Zone

Pandalus borealis

- The *Pandalus borealis* resource is currently in the Healthy Zone well above the Upper Stock Reference.
- The exploitation rate for 2013/14 is about 4%. The current Total Allowable Catch represents a potential exploitation rate of about 7%.

Pandalus montagui

- The *Pandalus montagui* resource is currently in the Healthy Zone well above the Upper Stock Reference.
- The exploitation rate for 2013/14 is about 10.7%. The current Total Allowable Catch represents a potential exploitation rate of about 11%.

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(Approved January 20, 2014)

Sources of information

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DFO. 2013. Assessment of Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in the eastern and western assessment zones (Shrimp Fishing Areas 2 and 3). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/031.

Tables

Table 1. Fishable and female spawning stock biomass estimates for Pandalus borealis *in the Eastern Assessment Zone for the 2006-2013 surveys. LCL and UCL are the lower and upper 95% confidence limits.*

		Weight (tonne)		
Year	Biomass	Mean	LCL	UCL
2013	Fishable	49636.90	38427	60631
2012	Fishable	60533.67	43074	79960
2011	Fishable	78530.23	23900	135037
2010	Fishable	71064.51	40234	108703
2009	Fishable	78754.88	48850	110115
2008	Fishable	51053.43	37117	66708
2007	Fishable	43305.97	31015	58346
2006	Fishable	32815.89	21969	44152
2013	Female SS	32049.10	26762	37607
2012	Female SS	41189.85	29498	54383
2011	Female SS	47806.80	13470	82926
2010	Female SS	43800.31	19025	79665
2009	Female SS	38856.32	23122	56820
2008	Female SS	27653.12	22507	39368
2007	Female SS	27698.44	19249	39007
2006	Female SS	16805.06	10523	23026

Table 2. Fishable and female spawning stock biomass estimates for Pandalus montagui in the Eastern Assessment Zone for the 2006-2013 surveys. LCL and UCL are the lower and upper 95% confidence limits.

		Weight (tonne)		
Year	Biomass	Mean	LCL	UCL
2013	Fishable	3534.28	1738	6208
2012	Fishable	28845.47	8582	48946
2011	Fishable	7739.99	2871	14285
2010	Fishable	7422.75	5714	9290
2009	Fishable	15679.12	6190	29774
2008	Fishable	14667.04	7287	21973
2007	Fishable	4828.25	3389	6673
2006	Fishable	2667.14	210	5122
2013	Female SS	2777.54	1301	4949
2012	Female SS	23552.02	6218	40985
2011	Female SS	3124.24	1599	4721
2010	Female SS	5819.10	4509	7136
2009	Female SS	8775.54	4205	13955
2008	Female SS	10659.82	4269	17047
2007	Female SS	1970.63	903	3490
2006	Female SS	2134.38	50	4219

Table 3. Fishable and female spawning stock biomass estimates for Pandalus borealis *in the Western Assessment Zone for the four surveys conducted. LCL and UCL are the lower and upper 95% confidence limits.*

		Weight (tonne)		
Year	Biomass	Mean	LCL	UCL
2013	Fishable	21998.56	15906	28519
2011	Fishable	19692.10	12468	27961
2009	Fishable	15543.95	10603	21650
2007	Fishable	14615.00	8192	22356
2013	Female SS	9785.03	7106	12829
2011	Female SS	6376.60	4182	8909
2009	Female SS	3839.38	2184	4344
2007	Female SS	3231.00	2281	4344

Table 4. Fishable and female spawning stock biomass estimates for Pandalus montagui *in the Western Assessment Zone for the four surveys conducted. LCL and UCL are the lower and upper 95% confidence limits.*

		Weight (tonne)		
Year	Biomass	Mean	LCL	UCL
2013	Fishable	45647.22	32899	59438
2011	Fishable	71557.90	40264	108612
2009	Fishable	46672.87	35026	73342
2007	Fishable	54044.50	25723	84280
2013	Female SS	26955.19	18016	35736
2011	Female SS	32549.40	20296	46119
2009	Female SS	17998.70	13908	22322
2007	Female SS	19277.30	8902	32302

Figures

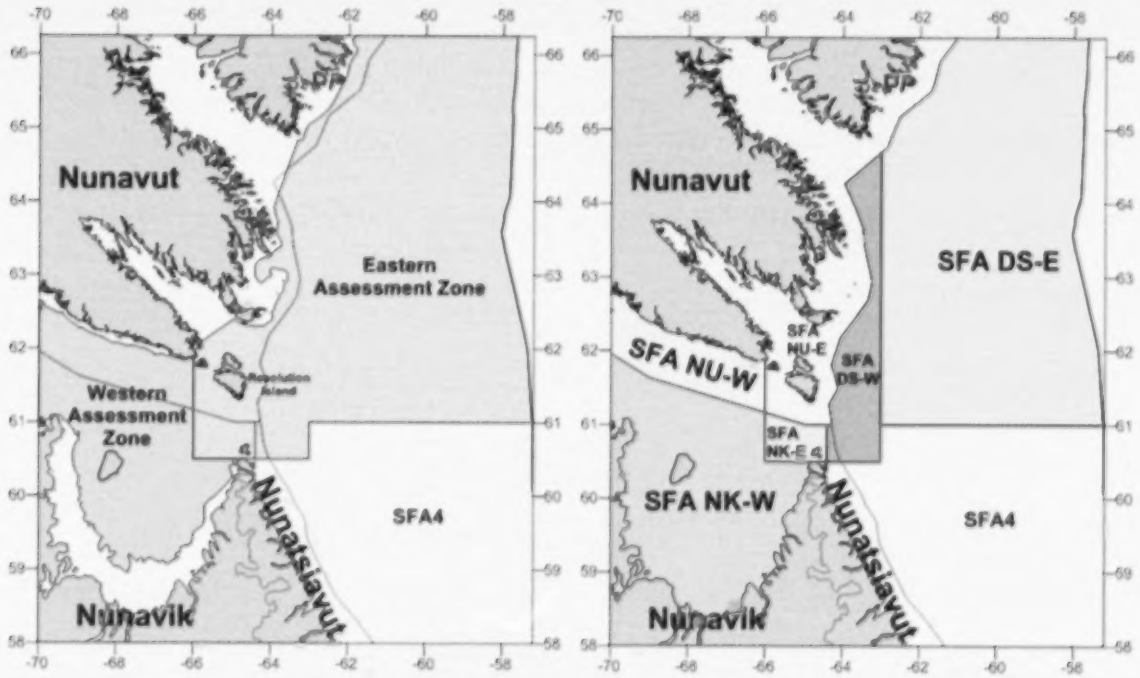

Figure 1. Location of the Western and Eastern assessment zones (left panel) and corresponding Shrimp Fishing Area (SFA) management units (right panel). Boundaries of the Nunavut (NU), Nunavik (NK) and Nunatsiavut Land Claims Areas are identified with red lines. Abbreviations for Davis Strait (DS), East (E), West (W) are used.

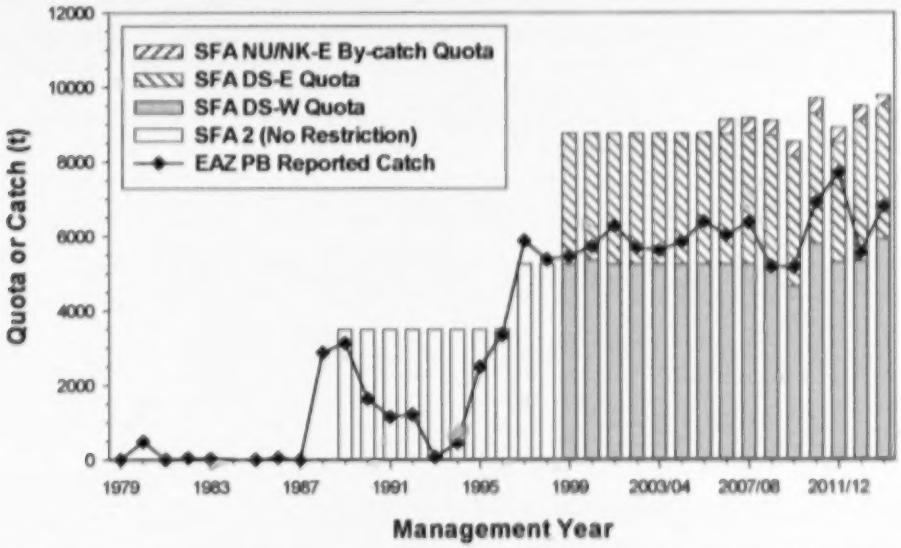

Figure 2. The Eastern Assessment Zone Pandalus borealis *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR). Catch based on CAQR as of 3 January 2014; since fishery is still open catch may not be complete for the fishing year. Quota for 1999-2012/13 renamed to correspond to new management areas.*

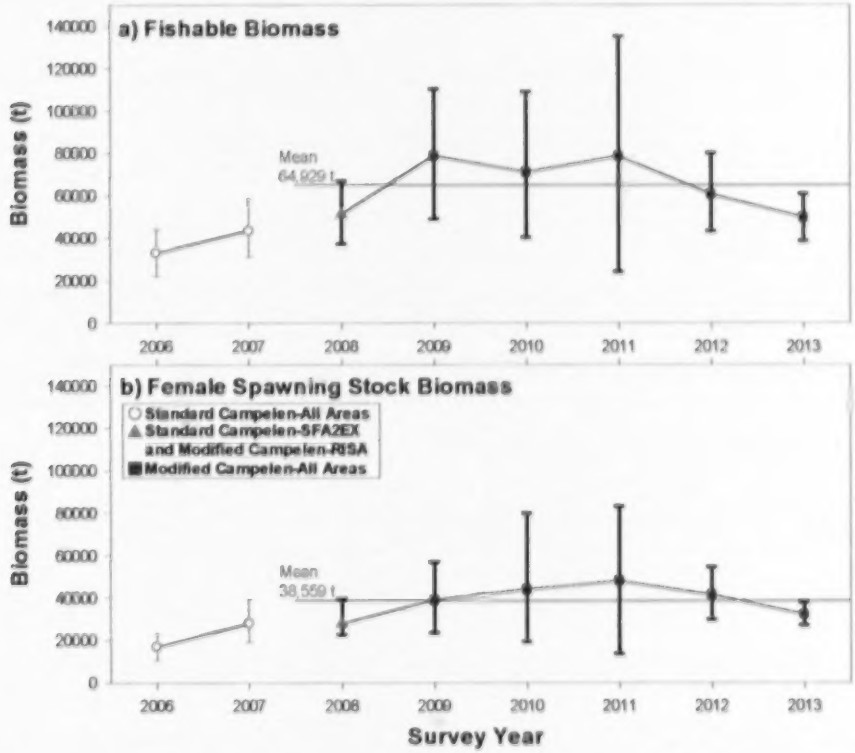

Figure 3. The Eastern Assessment Zone Pandalus borealis *a) fishable and b) female spawning stock biomass indices for the survey years 2006-2013.*

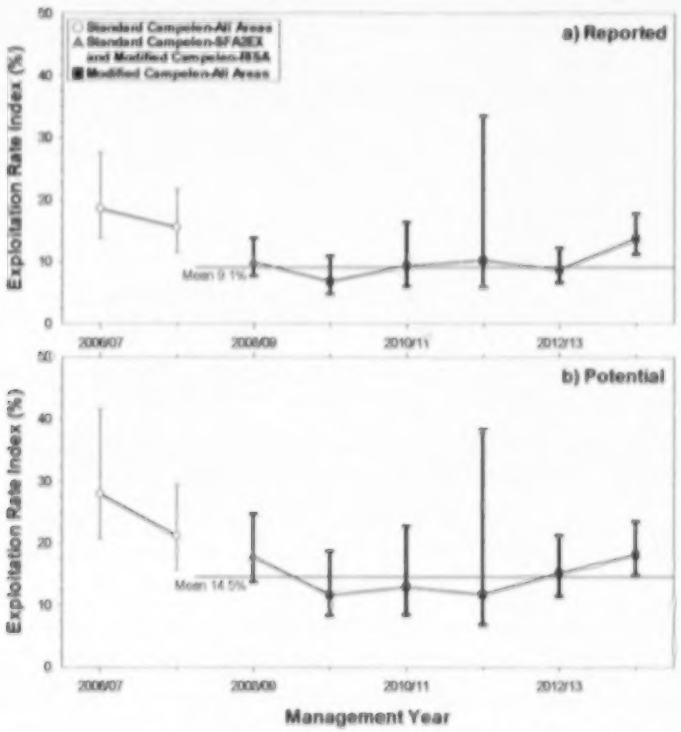

Figure 4. The Eastern Assessment Zone Pandalus borealis *a) reported and b) potential exploitation rate indices for 2006/07-2013/14.*

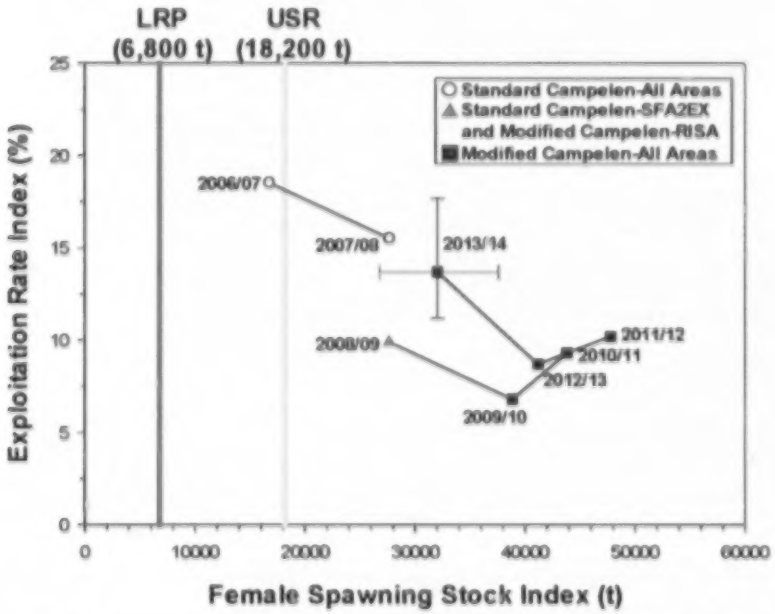

Figure 5. The Eastern Assessment Zone trajectory of Pandalus borealis *female spawning stock biomass and exploitation rate indices in relation to reference points. USR=Upper Stock Reference and LRP=Limit Reference Point.*

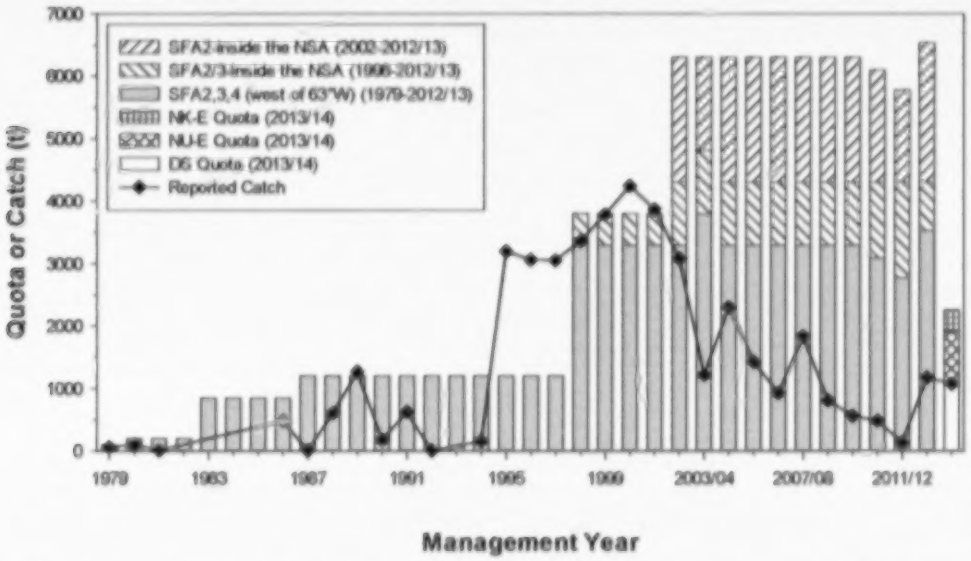

Figure 6. The Eastern Assessment Zone Pandalus montagui *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR). Catch based on CAQR as of 3 January 2014; since fishery is still open catch may not be complete for the year. New management units were implemented for the 2013/14 season.*

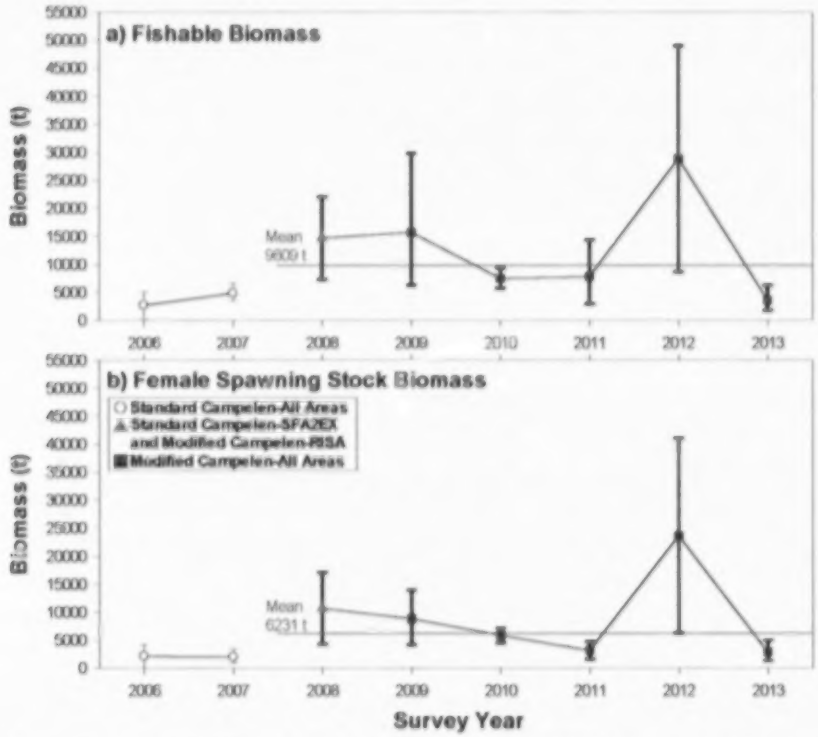

Figure 7. The Eastern Assessment Zone Pandalus montagui *a) fishable and b) female spawning stock biomass indices for the survey years 2006-2013. Mean of years 2008/09-2013/14 excluding 2012/13 is shown.*

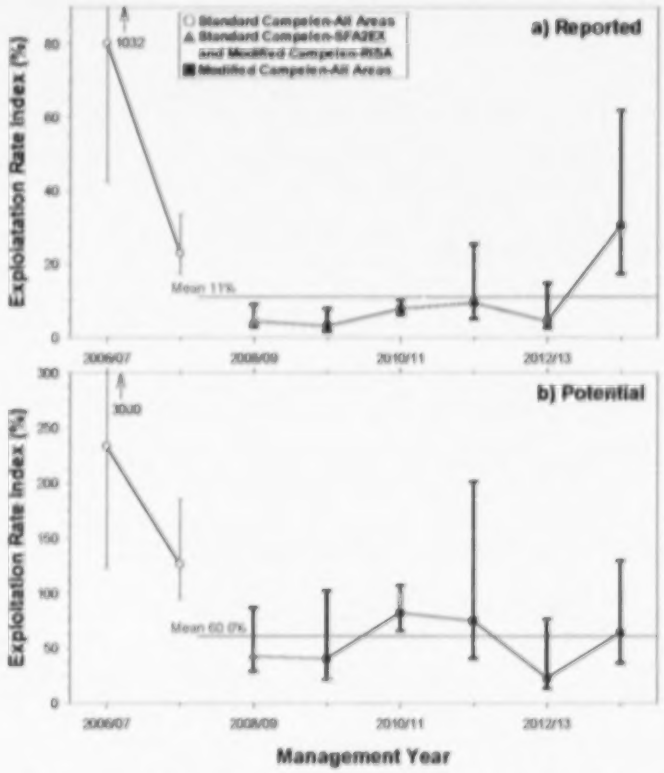

Figure 8. The Eastern Assessment Zone Pandalus montagui *a) reported and b) potential exploitation rate indices for 2006/07-2013/14. Mean shown includes 2008/09-2013/14 and excludes 2012/13.*

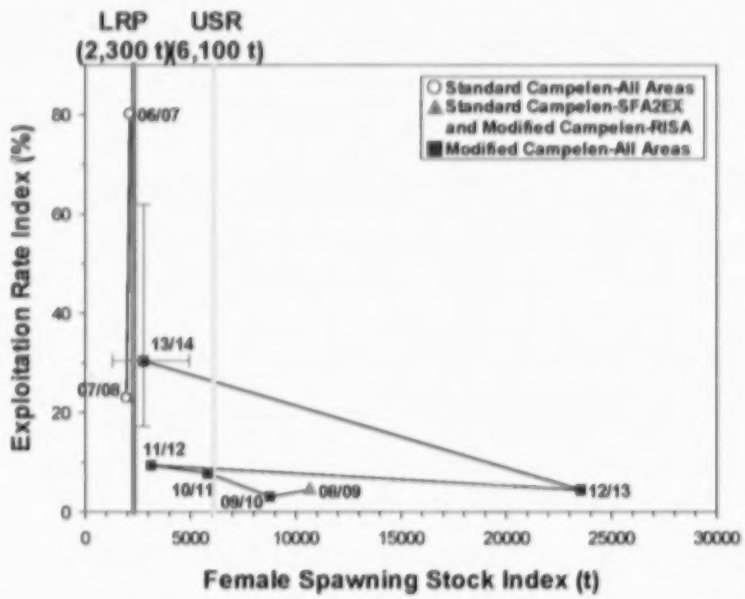

Figure 9. The Eastern Assessment Zone trajectory of Pandalus montagui *female spawning stock biomass and exploitation rate indices in relation to reference points. USR=Upper Stock Reference and LRP=Limit Reference Point.*

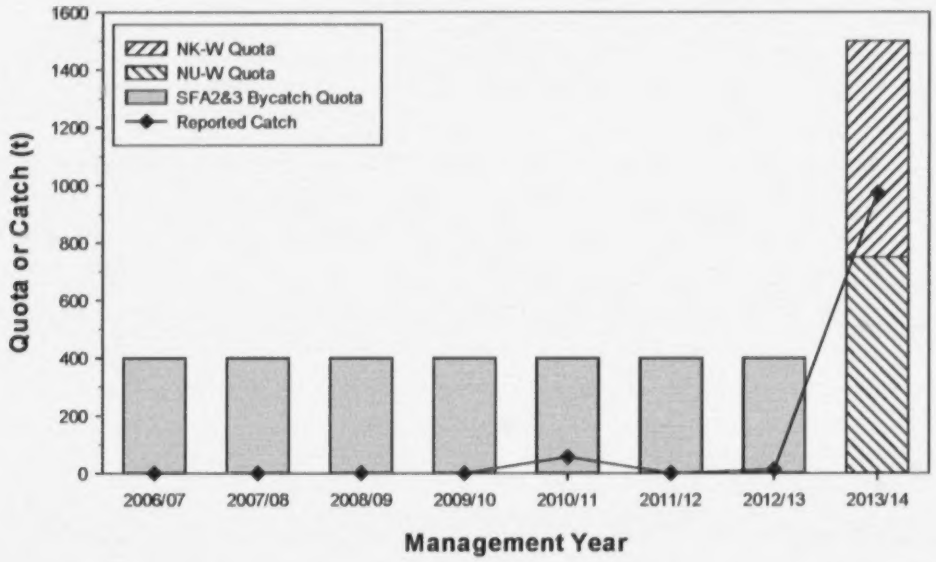

Figure 10. The Western Assessment Zone Pandalus borealis *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR) for 2013/14 and observer records prior to 2013/14. Catch based on CAQR as of 3 January 2014; since fishery is still open catch may not be complete for the year. New management units were implemented for the 2013/14 season.*

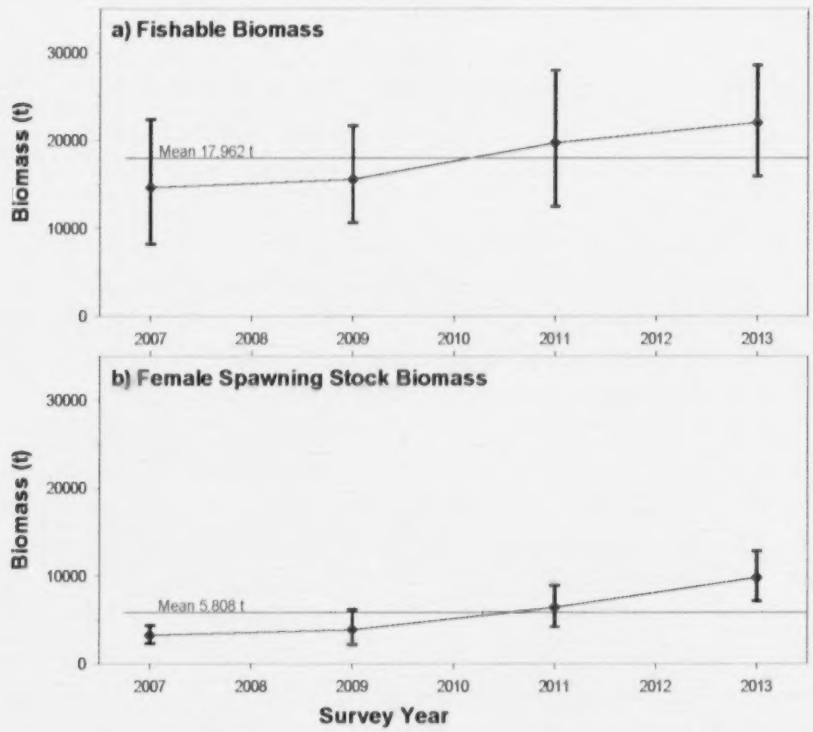

Figure 11. The Western Assessment Zone Pandalus borealis *a) fishable and b) female spawning stock biomass indices for the survey years 2007, 2009, 2011 and 2013. All years fished with the Cosmos trawl.*

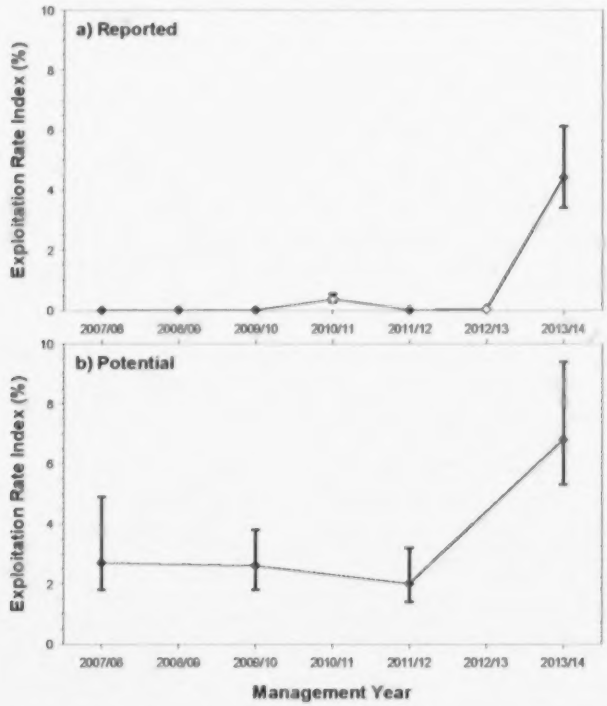

Figure 12. The Western Assessment Zone Pandalus borealis *a) reported and b) potential exploitation rate indices. Note that there was no survey in 2010 or 2012 so the exploitation rate was based on the fishable biomass from the previous year's survey.*

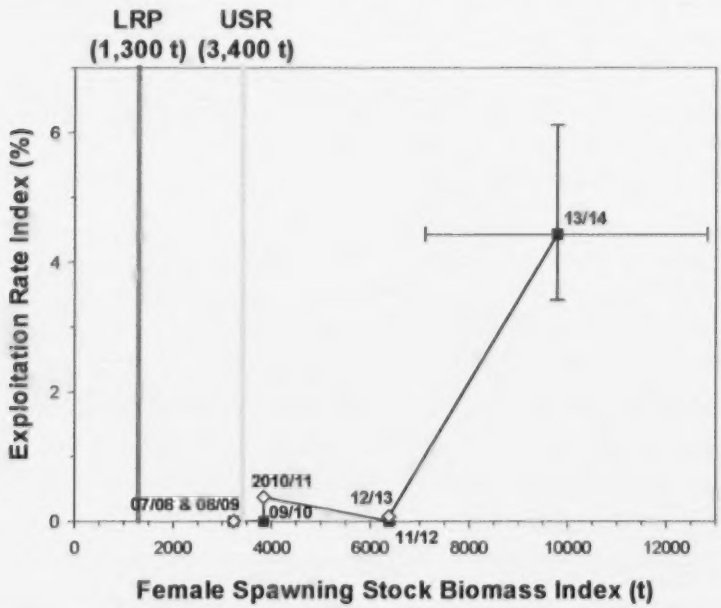

Figure 13. The Western Assessment Zone trajectory of Pandalus borealis *female spawning stock biomass and exploitation rate indices in relation to reference points. Note open symbols represent years when no survey was conducted. The exploitation rate in those years was based on the fishable biomass from the previous year's survey. USR=Upper Stock Reference and LRP=Limit Reference Point.*

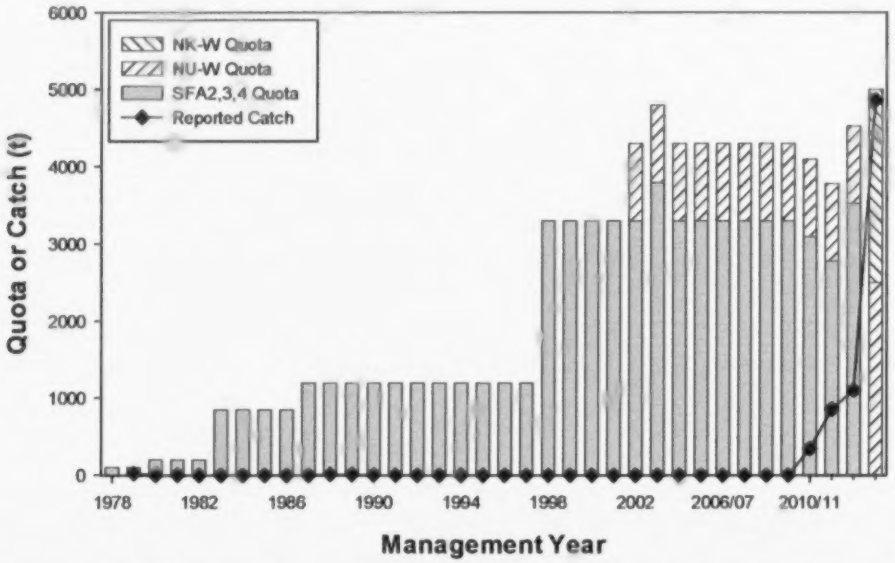

Figure 14. The Western Assessment Zone Pandalus montagui *TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR). Catch based on CAQR as of 3 January 2014; since fishery is still open catch may not be complete for the year. New management units implemented for the 2013/14 season.*

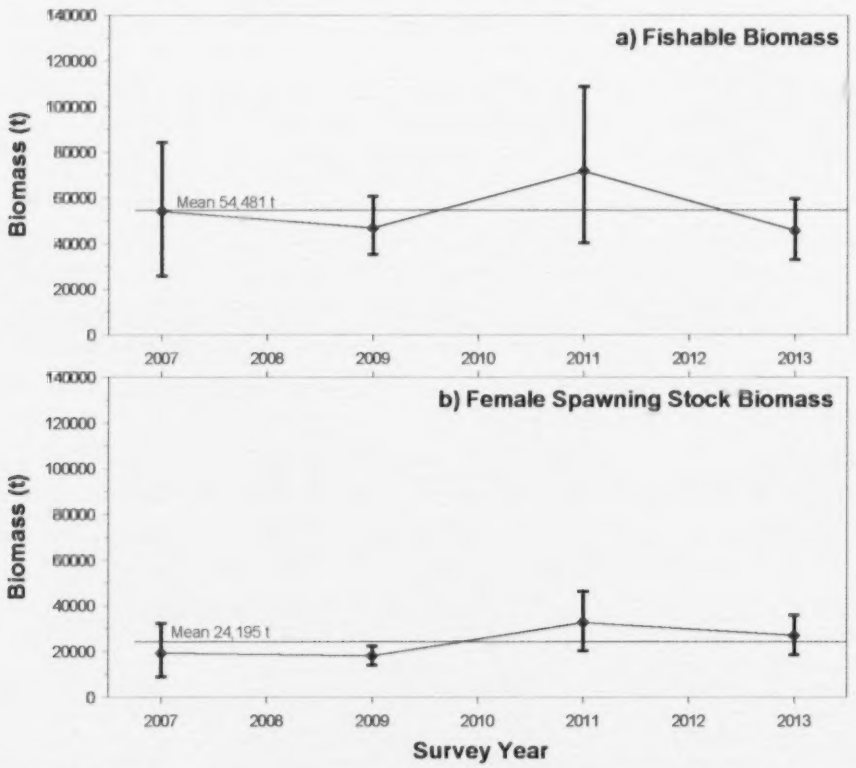

Figure 15. The Western Assessment Zone a) fishable and b) female spawning stock biomass indices of Pandalus montagui *for the survey years 2007, 2009, 2011 and 2013. All years fished with the Cosmos trawl.*

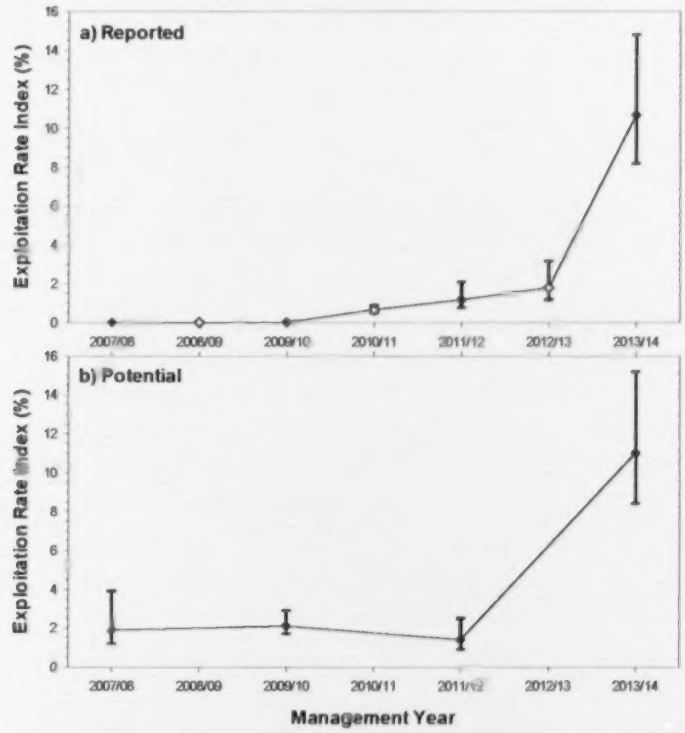

Figure 16. The Western Assessment Zone Pandalus montagui *a) reported and b) potential exploitation rate indices. Note open symbols represent years when no survey was conducted. The exploitation rate in those years was based on the fishable biomass from the previous year's survey.*

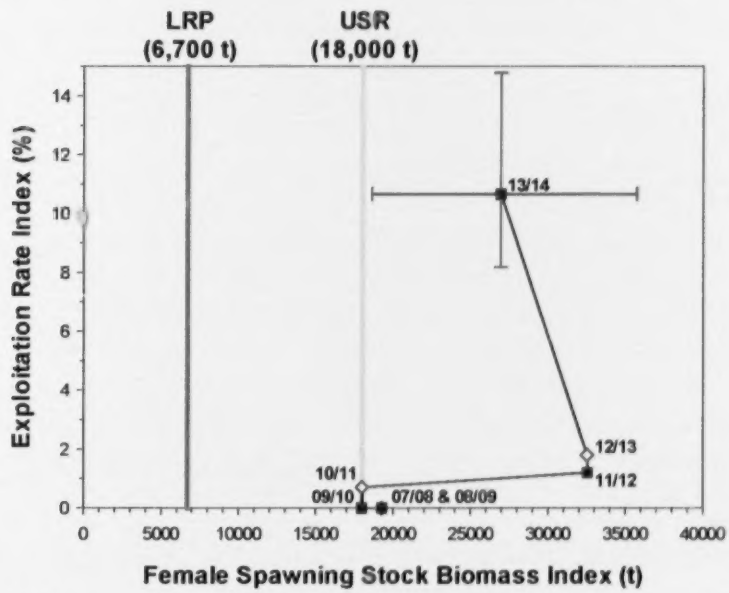

Figure 17. The Western Assessment Zone trajectory of Pandalus montagui *female spawning stock biomass and exploitation rate indices in relation to reference points. Note open symbols represent years when no survey was conducted. The exploitation rate in those years was based on the fishable biomass from the previous year's survey. USR=Upper Stock Reference and LRP=Limit Reference Point.*

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